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FIRE RESCUE

Understanding Ethanol and its Impact for Boca Raton Fire Rescue Services

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Certification Statement

I hereby certify that this paper constitutes my own product, that where the language of others is set forth, quotation marks so indicate, and that appropriate credit is given where I have used that language, ideas, expressions, or writings of another.

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Abstract

The problem was that Boca Raton Fire Rescue Services did not have the equipment or procedures to deal with a large scale ethanol spill or fire. The purpose of the research was to determine the safety procedures, training needs, policies and equipment required to effectively respond to an ethanol incident. Action research methodology was utilized to answer the research questions:

1. How did ethanol properties create a special challenge for Boca Raton Fire Rescue Services Department?
2. What industry safety features were employed in the production of ethanol that may be adapted for emergency response?
3. What challenges did fire departments feel they were facing trying to plan for the risks associated with the increased use of ethanol?
4. What training, techniques, and strategies were employed by other fire departments in their emergency response plan for ethanol spills or incidents?

The Florida Fire Chiefs' Association (FFCA) was used to distribute a 16 question survey to fire department members of the organization. Fire departments and industry equally provided classroom ethanol training to 57% of responders, while also providing field training to 67% of that group. Most respondents do not have SOP's, specialized equipment, AR-AFFF, or mutual aid agreements, dealing with ethanol.

An SOP was recommended and developed for implementation for Boca Raton Fire Rescue. The development of a risk reduction strategy for the facility was recommended along with a long term recommendation to identify all locations that may have ethanol in the city limits.

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Ethanol and Safety of Boca Raton Fire Rescue

Introduction

Ethanol production and use in the United States have increased substantially from 4 billion gallons in 2005 to over 9 billion gallons in 2008 (U.S Department of Energy (U.S. DOE), 2009). According to the Renewable Fuels Association (RFA), production was expected to reach 12.5 billion gallons in 2009 (Renewable Fuel Association, 2008). The increased use of ethanol appears to be for two main reasons. The phase out of Methyl Tertiary Butyl Ether as a gasoline additive with ethanol being used as the replacement oxygenating agent is the first reason (Powers, Alvarez, & Rice, 2001). The second reason is consumer demand for flex fuel vehicles, which are capable of operating on 85% ethanol and 15% gasoline according to the RFA's website (E-85, 2009). This blend of 85% ethanol and 15% gasoline is commonly referred to as E85.

In its August 2007 article, Bulk Reporter identified that many fire departments do not have the tools and training needed to effectively handle an ethanol or ethanol/gasoline fire (Penton, 2007). It was discovered that in Boca Raton, a company had 15,000 gallons of ethanol in use for daily operation. The problem is that Boca Raton Fire Rescue Services (BRFRS) does not have the equipment or procedures to deal with a large-scale ethanol spill or fire. The purpose of the research is to determine the safety procedures, training needs, policies, and equipment required to effectively respond to an ethanol incident. Action research will be used to identify the following research questions:

1. How do ethanol properties create a special challenge for Boca Raton Fire Rescue Services Department?

2. What industry safety features are employed in the production of ethanol that may be adapted for emergency response?
3. What challenges do fire departments feel they are facing trying to plan for the risks associated with the increased use of ethanol?
4. What training, techniques, and strategies are employed by other fire departments in their emergency response plan for ethanol spills or incidents?

Background and Significance

BRFRS is a mid size fire department with 207 personnel assigned to the Operations Division. The department has eight stations located within its 32 mile boundary. The city houses a combination of business and industrial parks as well as multi-family occupancies throughout its borders. The city has two sets of rail systems, one operating on the east side of the city and the second operating through the center of the city. Interstate 95, one of the major expressways for Florida, runs north to south through the center of the city.

During a routine inspection, it was discovered that a bio-pharmaceutical company housed 15,000 gallons of ethanol inside its building for daily operation in its production process. The fire department had no prior knowledge of the fuel being stored or used in the operations inside the facility. Upon further examination, it was discovered that there was no leak and spill containment nor fire suppression equipment or controls in place around the 15,000 gallon tank of ethanol. It was also noted that the bio-pharmaceutical company did not use the NFPA 704 rating system to identify the hazardous liquid (National Fire Protection Association, 2007). The building is located next to an interconnected waterway system and is approximately 200 feet from an eight story two hundred room hotel, as well as, one of the city's drinking water wells.

Thus, a spill at this building could result in contamination of the nearby well and ultimately the drinking water for the area.

The bio-pharmaceutical company plans to continue storing ethanol at 95% (E95) concentration and to use about 5,000 gallons per day in its daily operations. E95 is a blend of 95% ethanol and 5% gasoline. In addition to the filling of the ethanol tank, waste ethanol in concentrations between 25% and 70% will be transported from the property via tanker truck.

Adding to the increase use of ethanol, the State of Florida has made it mandatory that all gasoline sold in the state of Florida be blended with 10% ethanol by December 31, 2010 (Jessen, 2008). This means that firefighters responding to vehicle fires will encounter fuel tanks that contain a mixture of gasoline and ethanol. Furthermore, according to the Alternative Fuels and Advance Vehicle Data Center, the State of Florida has 30 fuel stations that provide ethanol fuel (E85) for vehicles (E85 Fuel Stations in Florida, 2009). Fourteen of those stations are within 50 miles of Boca Raton. In 2003, less than 200 service stations in the United States sold E85 fuel and in 2008 number ballooned to 1,900 stations (E85 Station , 2009).

As the use of ethanol continues to increase, BRFRS will be responding to an increased number of vehicle fires involving ethanol fuels. The fire department does not have a standard operating procedure (SOP) for responding to flammable liquids including ethanol. This paper relates to the operational objective of responding to emergency issues in a timely manner of the U.S. Fire Administration. It relates to the Risk Prevention and Risk Mitigation of the Executive Analysis of Community Risk Reduction Course.

Literature Review

Chemical and Physical Properties of Ethanol

The properties of ethanol are similar to those of gasoline. Denatured ethanol (E95) is a clear flammable liquid that has a combustible range from 3.3% to 19%, a specific gravity of 0.79, a vapor density of 1.6, a flash point of -5°, and is completely miscible with water (Midland, 2008). It is a member of the alcohol family (Burke, 2010). According to Materials Safety Data Sheets from Marathon Petroleum Company, mid-grade gasoline with ethanol is a clear or colored volatile liquid mixture with a strong hydrocarbon odor (Parker, 2005). It has a flammable range of 1.4% to 7.6 %, a vapor density of 3-4, a specific gravity of .070, and a flash point of -50F (Parker, 2005). The flammable range for ethanol fuel is significantly wider than that for gasoline. Just like ethanol, gasoline is listed as a Class 3 flammable liquid by the Department of Transportation (DOT) Emergency Response Guidebook (U.S. Department of Transportation, 2008). The ERG recommends following Guide 128 for gasoline involved incidents and Guide 127 for ethanol involved incidents (US DOT, 2008).

The listing difference between Guide 127 and 128 is one is for polar/miscible and the latter is for non polar/immiscible. Ethanol is a water soluble, miscible polar solvent that requires alcohol resistant (AR) foam to extinguish an ethanol fire (White, 2007). White wrote in his article that even at 10% dilution it is still combustible (White, 2007). He further explained that if 1000 gallons of ethanol spilled, it would take approximately 9000 gallons of water to dilute it below its combustible range (White, 2007).

Blank, in his article for the Boston Globe February 27, 2008, recognized that fires involving ethanol are harder to put out than those involving gasoline and requires special foam stating, that it eats traditional firefighting Aqueous Film Foaming Foam (AFFF) (Blank, 2008).

In its Safety Alert of September 19, 2006, the Pipeline and Hazardous Materials Safety Administration (PHMSA) alerted first responders that fires involving ethanol in concentrations greater than 10% should be treated differently from gasoline fires of the past (U.S. Department of Transportation 2006). Although both are listed as Class 3 flammable liquids, the firefighting foam required for each is different (Burke, 2010).

In the NFPA Journal article of Mar/Apr 2008, Guy wrote that ethanol can only be extinguished with alcohol resistant foam (Colona, 2008). Alcohol resistant foam is foam that contains a special polymer to prevent degradation of the foam blanket, and is required for fires involving ethanol (Butters, 2008). Guy further explained that the foam should be directed onto a vertical surface when possible and allowed to run down onto the fuel (Colona, 2008). The Ethanol Emergency Response Coalition (EERC), after conducting foam tests, indicated in its results that AR-AFFF was the only foam agent that could be used on both 95% ethanol solution as well as blended gasoline (Resources, 2009).

US DOT in its Safety News of September 19, 2008 published the recommended foam application rate of the IAFC of 0.2 and 0.3 for ethanol spills and fires along with the advisory that direct application to fuel surfaces will be ineffective (Emergency Response Involving Ethanol and Gasoline Fuel Mixtures, 2008). Chief Butters wrote that the application nozzles for foam are of significance to ensure proper foam air mixture to be produced (Butters, 2008). In addition, because the quantity of water needed to sustain a foam operation in an ethanol incident may be substantial, the available water supply and the hose diameter are significant (Butters 2008).

Ethanol Production Facilities

Ethanol production facilities come with a special set of hazard (Jaehne, 2008). Plants are required to be located with a minimum half mile buffer zone from surrounding population and structures (Jaehne, 2008). Associated risks with industrial production are grain bin dust explosions, confined space, and high angle rescue (Jaehne, 2008). Some facilities, according to Buchanan are installing fire and explosion detection and suppression equipment to minimize the hazards created by dust (Buchanan & Jacobson, 2008). According to White in his article for Fire Chief magazine, some facilities have good protection with fixed foam systems, monitors and sprinklers while others do not (White, 2009).

Ethanol Storage Facilities and Dispensing Devices

The US Department of Energy (DOE) recommends that specific materials be used with fuel blends that contain ethanol because of the corrosion and degradation caused by ethanol (Laboratory, 2008). The problem of degradation was so significant that, in 2006 Underwriters Laboratory (UL) suspended authorization for manufacturers to use UL markings on components for fuel-dispensing devices that specifically reference compatibility with alcohol-blended fuels that contained greater than 15 percent alcohol such as ethanol, methanol, or other alcohols (Laboratory, 2008). Metals such as steel, iron, and bronze have resistance to ethanol corrosion, and are, therefore, E85 compatible materials that can be used for the storing and dispensing of ethanol blended fuels (Laboratory, 2008). It was further directed by the U. S. DOE that Components made of brass, zinc, lead, aluminum or other soft metals should be avoided (Laboratory, 2008). Storage tanks constructed of the proper materials that were previously used for storing other types of fuels may be used if properly cleaned (Laboratory, 2008). According to DOE, UL has completed the research to assess the safety performance of E85 dispenser

assemblies and will be accepting certification requests for gasket and seal materials (Laboratory, 2008).

Transportation of Ethanol

Ethanol is shipped to the end user via rail, cargo tank truck, and barges from refineries and distribution facilities as a 95% pure product (Hayes, 2009). Ethanol is the number one commodity ship by rail according to the Federal Railroad data (Butters, 2008). Hayes wrote in the article that shipments may be misleading as placards on shipments may be label 1203, 1987 or the new 3475 (Hayes, 2009). According to the Illinois Fire Service Institute, since 2000 there have been 26 major fires related to ethanol in the United States, including three tanker truck fires and five derailed train fires (Illinois Fire Service Institute, 08).

In February 2008, McKenzie Valve & Machining Co. and Carolina Seal, Inc. issued a press release and chart of the specific type of valves and O-rings that should be used when companies are shipping ethanol fuel products (Renewal Fuel Safety Advance, 2008). The goal of the initiative taken on by these two companies was to reduce the number of non accident releases related to seals and valves failure during ethanol shipping (Renewal Fuel Safety Advance, 2008).

The Association of American Rail Roads in its Pamphlet 34 recommends that grounding and bonding should be in place during loading and unloading operations of flammable liquids (Dorsey, 2008). This is also echoed in the Technical Information & Safe Handling Guide for Methanol (Methanex, 2006). They further stated that selecting an authorized tank car for the product to be loaded is a recommended practice (Dorsey, 2008).

Emergency Responders' Challenges

In the July 10, 2009 edition of the Bio Fuel Daily, staff writers noted that ethanol has become an integral component of American fuel supply therefore responders should be well

trained and prepared to respond to ethanol related emergencies (Bio Fuel Daily, 2009). The article further stated that it is imperative that first responders have the knowledge necessary to respond to these types of incidents (Bio Fuel Daily, 2009).

Bulk Transporter in its August 1, 2007 edition wrote the problem in the negative. The article noted that emergency responders do not have the tools or training to effectively deal with ethanol fires and spills (Penton, 2007). Most fire departments do not have comprehensive response plans to handle ethanol emergencies (Penton, 2007). To address this problem, the Ethanol Emergency Response Coalition (EERC) was formed with the mission “To enhance the knowledge, capability and readiness of operational emergency response agencies to effectively respond to fires, spills and other emergencies involving ethanol and ethanol blended fuels” (About, EERC).

The risk with ethanol and ethanol blended fuels may vary greatly and may be significant. Many communities may have a major rail line, highway, or waterway that supports the transportation of ethanol and must be ready to handle a spill or fire (Butters, 2008). David White in an article written for FireChief.com stated that firefighters might have to deal with 100 tanker cars of ethanol sitting across as many as six tracks in some cases (White, 2009).

Jaehne further wrote that firefighters responding to vehicle fires involving private automobiles need be aware of the possibility that ethanol could exist (Jaehne, 2008). Most fire departments have only a limited supply of foam and many do not have the correct type of foam to fight an ethanol fire according to the Bulk Transporter article (Penton, 2007).

Procedures

The purpose of the survey was to provide answers to two research questions:

1. What challenges do fire departments feel they are facing trying to plan for the risks associated with the increased use of ethanol?
2. What training, techniques, and strategies are employed by other fire departments in their emergency response plan for ethanol spills or incidents?

The information collected would help guide the development of SOP's and training for BRFRS.

The survey was designed to differentiate fire department responses between organizations that have facilities with ethanol and those that do not. The response information can be compared to those that have and those that do not. The survey also added a question to identify the organization by zip code. If more than one response came from the same organization, only one response would be accepted and all of the additional responses would be eliminated. Three open ended questions in the survey allowed the respondent to share information dealing with:

1. Training or actual techniques that are used in dealing with ethanol fires?
2. Information about specialized equipment that may be used during an ethanol emergency? and
3. The top challenges that were faced in getting ready for an ethanol emergency?

The initial survey population was identified as the fire departments in the states of Illinois and Minnesota. The Fire Chiefs' Association for each state was contacted with the request to distribute the survey to members of their respective organization. Illinois and Minnesota were selected because they are the top two ethanol production states in the United States (U.S. DOE, 2009). Additionally, those states have the highest number of E85 stations within their states (U.S. Department of Energy(US DOE), 2009). Communications occurred via the phone as well as email but no responses were received from any organizations in Minnesota or Illinois.

The Florida Fire Chiefs' Association (FFCA) was contacted to distribute the survey to the members of this organization. The survey population targeted was all of the fire department organizations that are members of the Florida Fire Chiefs' Association. Even though Florida does not have a production facility, the state has thirty E85 stations located throughout the state (U. S. DOE , 2009). Fire service organizations within Florida have been responsive to surveys in the past.

A sample questionnaire was distributed using the Palm Beach County Fire Marshal's Association. The survey was distributed to the Fire Marshals within Palm Beach County for their review and several questions were modified for clarity based on the feedback from the sample group. The survey was distributed through the FFCA with a response period of one week. The survey was collected through Survey Monkey.

The FFCA is comprised of 403 fire departments members from within the state of Florida. Both volunteer and career departments have the opportunity to be members of the association. FFCA emailed the members the introduction letter along with a link to the survey on Survey Monkey. Members could complete the survey online and the information collected automatically for analysis. The instrument was a 16 question survey that took approximately eight minutes to complete and was accessible for a period of one week. Following this two week period, the survey was closed and respondents could no longer access the survey. There were two hundred responses to the survey.

Results

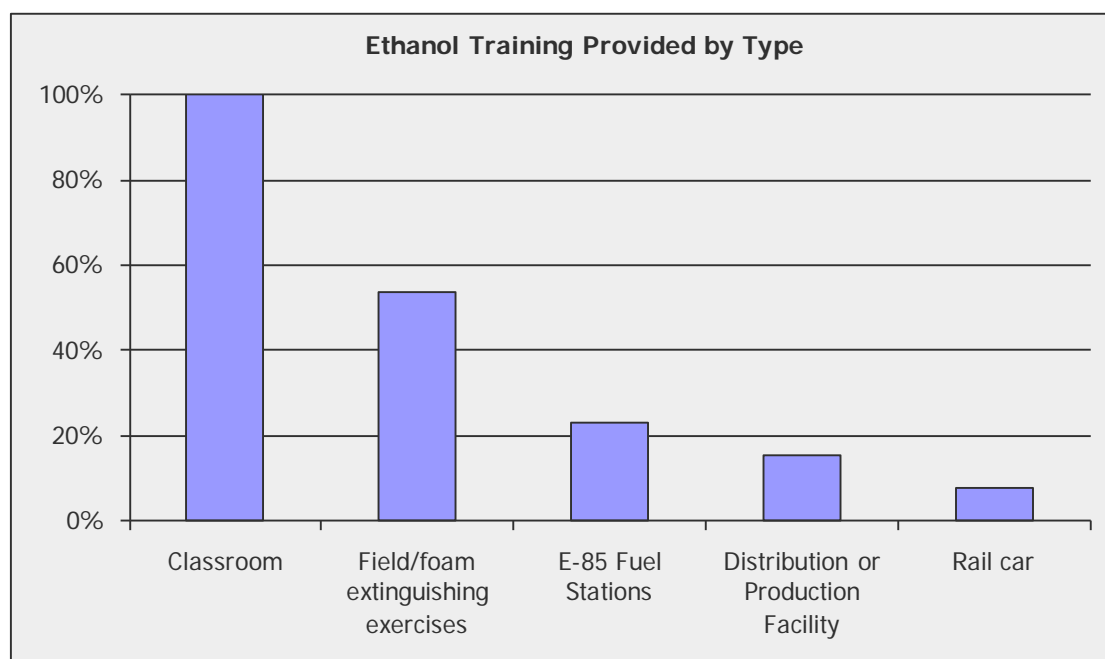
The first question asked participants: *Do you have an E-85 fuel station or distribution center or production facility in your jurisdiction?* 26% of respondents answered "yes".

The second question asked participants: *Do you provide training to fire fighters in handling ethanol emergencies?* Fifty-seven percent of total respondents answered “yes” that training is provided. When assessing only the responses of the fire departments with an E-85 station, distribution center, or production facility in their jurisdiction, 83% provided training.

The third question asked participants: *Does the training provided include any or all of the following combination classroom or field choices?* Chart 1 represents the responses to question three from respondents who answered “yes” to providing training. All of the respondents who provided training offered classroom delivery. In addition to classroom training, 69% of the respondents also supplied field training. Of the respondents with an E-85 station, distribution center, or production facility in their jurisdiction, 50% provided field/foam exercises and only 17% provided E-85 station training.

Chart 1

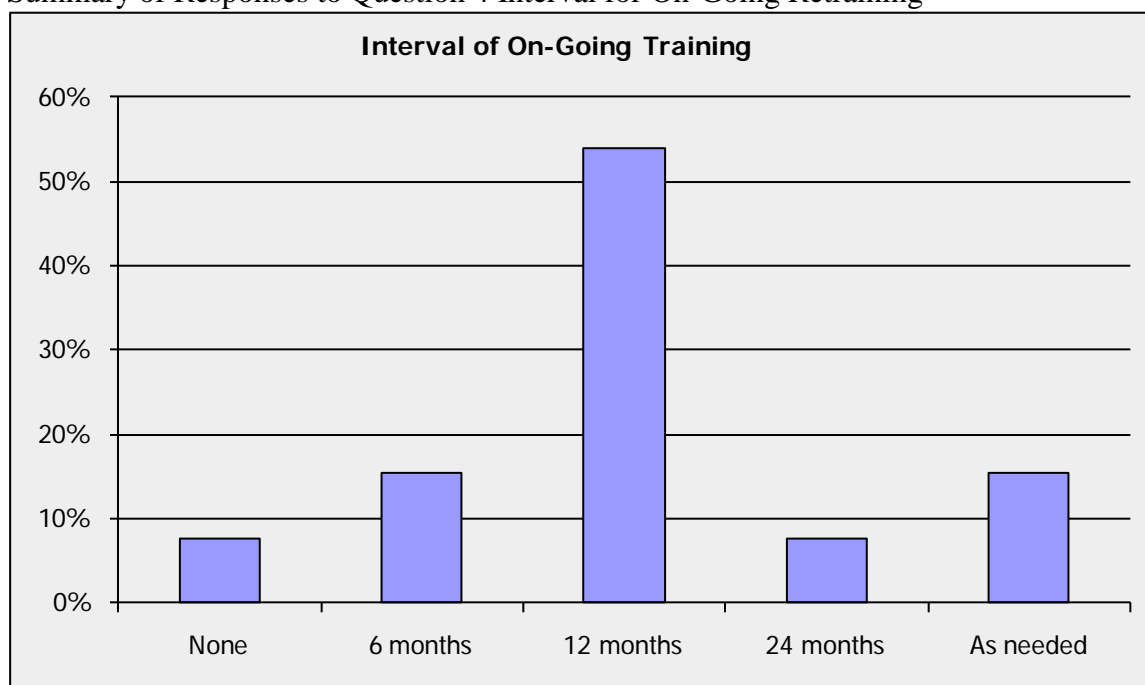
Summary of Responses to Question 3 Training Provided by Type



The fourth question asked participants: *How often do you provide on-going training following the initial training?* Of the respondents who provided training as represented in chart 2, 54% provide training on an annual basis, while 15% provide semi-annually, 8% every 24 months, and 15% as needed.

Chart 2

Summary of Responses to Question 4 Interval for On-Going Retraining



The fifth question asked participants: *Who provided the initial training?* The majority of the initial training was provided by two groups, the fire department and private industry. Each group, according to the respondents, provided 38% of initial training. The IAFC training contributed to 23% of the total training by respondents.

The sixth question asked participants: *Do you have written SOP's to deal with ethanol emergencies?* Ninety-one percent of total respondents do not have a written SOP for handling ethanol emergencies. Only eight percent of respondents who provide ethanol emergency

response training have a written SOP and none of the respondents with an E-85 station, distribution center, or production facility in their jurisdiction have a written SOP. One SOP provided was a unit response plan rather than a guideline or procedure for operating at an emergency incident.

The seventh question asked participants: *Do you have a pre-plan of ethanol facilities in your jurisdiction?* Of the 26% of total respondents with an E-85 station, distribution center, or production facility in their jurisdiction, only 50% have a pre-plan of the facilities.

The eighth question asked participants: *Do you have mutual agreements for ethanol response with other surrounding jurisdictions?* Of the total population of respondents, 30% of the participants have mutual agreements for an ethanol response with other surrounding jurisdictions, while 50% of respondents with an E-85 station, distribution center, or production facility in their jurisdiction have mutual agreements. Fourteen percent of respondents with mutual agreements with other surrounding jurisdictions did not provide training in responding to ethanol emergencies.

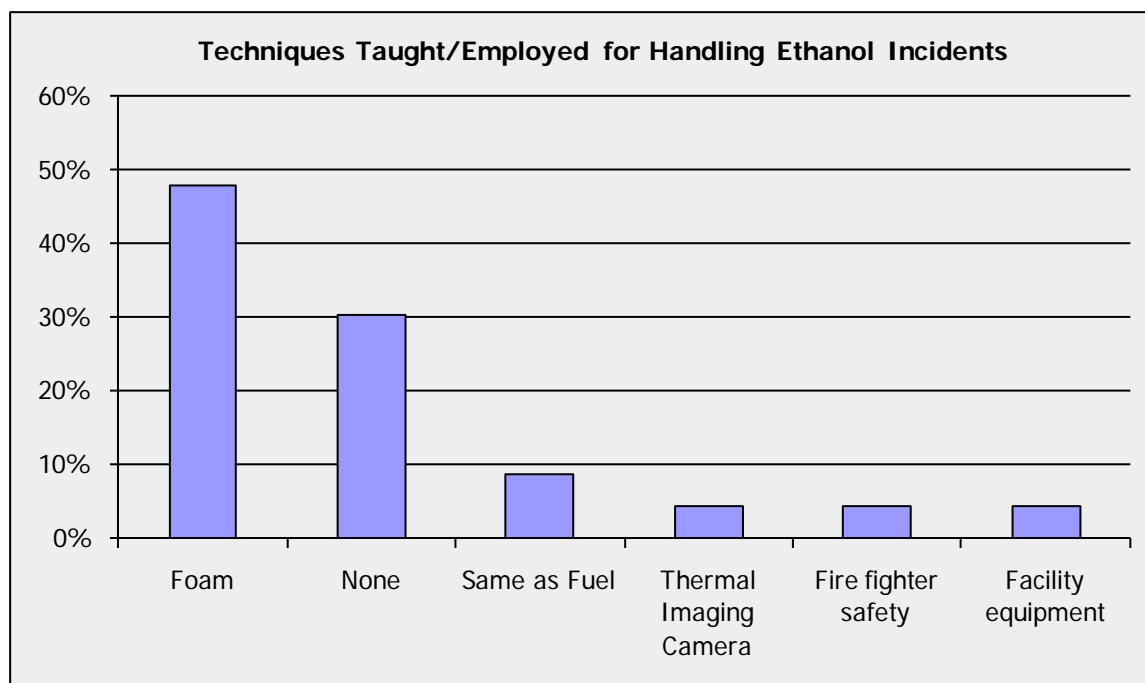
The ninth question asked participants: *What safety procedures do you have in place or established to respond to ethanol incidents?* The responses were classified for easy evaluation. Twenty-six percent of respondents have procedures for dealing with ethanol that are the same as used for other flammable liquids. Twenty-two percent of respondents have procedures, which require the use of foam in handling ethanol emergencies. Thirty percent of respondents have no procedures in place for responding to ethanol incidents. Four percent of respondents stated procedures are being developed for their organization. Four percent of respondents' procedures entailed using personal protective equipment. Thirteen percent of the responses could not be categorized because their responses were not relevant to safety procedures. Of the respondents

with an E-85 station, distribution center, or production facility in their jurisdiction, 50% have safety procedures in place, which require the use of foam while 17% have procedures which are the same as for other flammable liquids. One-sixth of respondents with a safety procedure in place also have a written SOP.

The tenth question asked participants: *What techniques do you teach and/or employ for fires involving ethanol incidents?* Although 48% of respondents teach and/or employ the use of foam, one-third of this group reported having conflicting safety procedures in place which call for responding to an ethanol incident the same as for a flammable liquid and only 36% reported providing field/foam training. Nine percent of respondents apply the same technique for ethanol incidents as used for flammable liquids. The percentage of respondents who used thermal imaging, fire fighter safety, and facility equipment was four percent each. Thirty percent of respondents reported no method of dealing with ethanol incidents. Fifty percent of respondents with an E-85 station, distribution center, or production facility in their jurisdiction teach and/or employ techniques using foam and had procedures which used foam in handling ethanol incidents.

Chart 3

Summary of Total Responses to Question 10

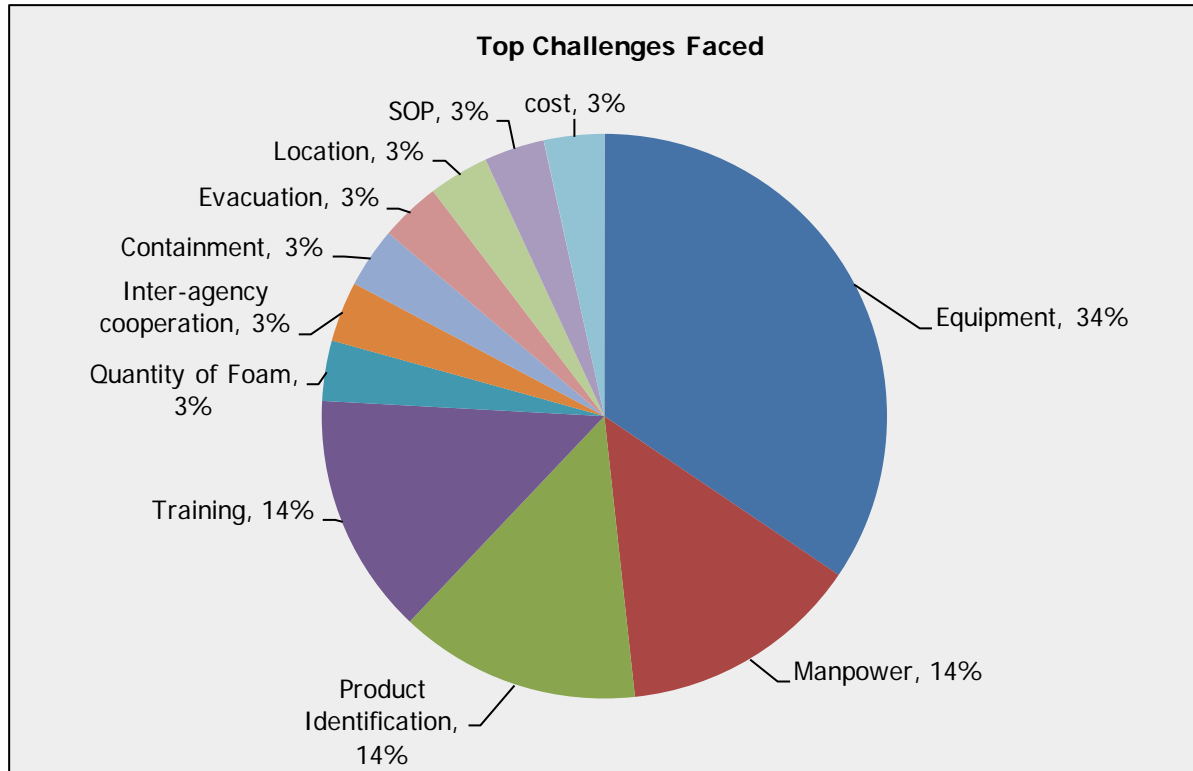


The eleventh question asked participants: *What specialized equipment do you use to deal with ethanol emergencies?* Ninety-one percent of respondents do not use specialized equipment when handling ethanol emergencies. Four percent of respondents used containment socks and the other four percent used specialized foam vehicles.

The twelfth question asked participants *to list the top five challenges they are facing (or have faced) trying to plan for and respond to ethanol emergencies.* Chart 4 displays a list of the top challenges faced by all respondents in planning for an ethanol emergency. All of the responses were categorized in one of the broad based categories listed on the chart. Lack of the proper equipment is the number one concern for the majority of the respondents. Inadequate manpower, product identification, and training were all equally reported as the next major challenge.

Chart 4

Summary of Top Challenges Faced for Planning



Questions 13 through 15 deals with the following demographics: *city, zip code, and rank*. These questions were used to determine if more than one response was received from an organization. No survey responses were duplicated from the same organization and therefore none was excluded from the evaluation.

The sixteenth question is an open ended question which allows the participants to provide additional information which may be evaluated for additional relevance. No additional information was provided by respondents for this question.

Discussion

The results of the survey varied in comparison to the written literature. Bulk Transporter in their article noted that responders do not have the training or tools to deal effectively with ethanol fires (Penton, 2007). The survey indicated that there is some truth to that statement. Forty

three percent of the total respondents did not have training provided for handling ethanol emergencies. Of fire departments that have ethanol facilities in is their jurisdiction 13%thirteen percent did not have any training and 31% offered only classroom training. Only 54% of the departments have on-going training on an annual basis. Bio Fuel Daily recognized that responders should be well trained with the knowledge base to handle an ethanol event (Bio Fuel Daily; 2009).

The quality of the training of the responders can be questioned based on the responses. Seventy six percent of the initial training was equally provided by fire departments and private industry. Considering that 96% of the total respondents do not have SOPs and 50% of those with ethanol facilities do not have pre-plans or mutual aid agreements, is the knowledge acquired during these training sessions enough to have responders appreciate the inherent dangers of an ethanol spill or fire? According to the Bulk Transporter, most fire departments only have a limited supply of foam (Penton, 2007). One participant provided a unit response plan for fuel spills was contacted with a follow up question. The question asked was to verify AR-AFFF was being used in their department's response to ethanol or gasoline fuel spills or fires since it was not written on the response plan provided. The reply was that they do not have AR type foam but in fact the department was using wet water. Even though ethanol is a Class 3 flammable liquid, it cannot be handled like gasoline (Blank, 2008). Burke in his article wrote that firefighting foam needed for ethanol and gasoline are different noting that AR-AFFF is needed for ethanol incidents (Burke, 2010).

It appears that respondents did recognize that foam is needed as this was the number one choice to the question on techniques that are taught or used for ethanol incidents. The need for the right equipment, manpower resource and training are the top choice when respondents were

asked to list the top challenges they were facing. DOE, in the Fuel Dispensing Handbook, acknowledges that equipment constructed of specific metals must be used if ethanol will be in contact with the surface (Laboratory, 2008). Additional equipment may be needed for using the foam since a type II application is recommended and has proven to be the best application type when dealing with an alcohol fire (Laboratory, 2008).

From the literature review and the survey, it is clear that BRFRS should develop a preplan for the site mentioned and procedures for handling flammable liquids spills including ethanol. All sources identified AR-AFFF is needed on polar solvent fires but this foam is also effective on gasoline fire. Since product identification is listed as a challenge and a problem for responders, it may be wise for BRFRS to only use AR-AFFF on all flammable liquids spills and fires. A price comparison showed that it costs 25% more per five gallon to purchase AR type foam. The increase cost is approximately \$2,400.00 for the first budget year to supply all of the apparatus with AR type foam.

The responses from the survey will assist with the overall direction for BRFRS in dealing with flammable liquids including ethanol. A new SOP, shown in Appendix A, has been developed because of the information gathered in the research. Implementation and training will take into consideration responses to the survey to provide the best successful prevention and mitigation strategies. Field and classroom training will be used to provide the knowledge and skills necessary to effectively handle a flammable liquids incident. Supplemental research will be conducted to determine transportation routes of travel for supplier distributing products and mutual aid partners that may be able to respond to an ethanol incident with AR foam.

Recommendations

Based on the information gathered, it is recommended that BRFRS adopt a new flammable liquids SOP effective April 30th, 2010. The new SOP is identified in appendix A. Along with the adoption of the SOP, the fire department should transition to AR-AFFF only on all fire apparatus except the Brush Truck. Foam purchased in the future should only be AR-AFFF with the one exception for wild land firefighting. TAPIRS 212, appendix C should also be accepted as amended with an effective date of April 30, 2010, to reflect foam concentration for polar solvents will be used on all flammable liquids fires.

Training associated with this recommendation is currently being schedule for the entire fire department. Many authors believed that responders arriving at ethanol incidents do not have the understanding of the properties of ethanol to effectively mitigate the emergency. The initial classroom training recommended for use is the IAFC's *Ethanol: Response Considerations*. This training program was developed by the IAFC in conjunction with the EERC, the RFA, Ansul Fire Protection, Industrial Fire World, Williams Fire Hazard Control and International Liquid Terminals Association. The training package is currently available, therefore little lead time is necessary and the fire departments can add the classroom portion of the training to its current training schedule. Future field training should be developed in conjunction with organizations such as EERC or Transportation Community Awareness and Emergency Response (TransCARE) using the departments training facility and railroad tank cars. The TransCARE program is funded by Union Pacific Corp and Dow Chemical Co (Beville, 2009).

It is also recommended that preplans be developed for the bio-pharmaceutical facility as a target hazard because for the presence of ethanol. The preplan should address safe guards installed at the facility, evacuation, mitigation strategies and foam calculations for a worst case

spill or fire. Attached to this preplan should be a resource list created through the Palm Beach County Fire Chiefs Association identifying which organizations have AR-AFFF and the quantities on hand.

To accomplish the resource list, the Palm Beach County Fire Chiefs Association can be contacted with the request to send out the survey to all of its members. The responses will be compiled in a spread sheet and shared with all of the organizations.

It is recommended that a two phase risk reduction plan be activated. The first would include the Fire and Life Safety Division of the fire department and the bio-pharmaceutical company working together for the community good. The division should facilitate the daily operations and storage into becoming code compliant and thus reducing the risks of a spill or fire to the community. The second part of the risk reduction plan would include the City's Utility Department. A mitigation plan should be developed with the Utility's Department that in the event of a spill of fire, the drinking water for the community and the water way system would be protected.

It is recommended that hazardous materials equipment used for flammable liquids mitigation be re-evaluation for compatibility with ethanol. The literature review noted that ethanol causes corrosion and deterioration of some metals and it should be imperative to identify that the equipment the fire department may used will not deteriorate (White, 2007). The fire department should also develop a schedule for rotating fuel stored in fuel containers and used in power tools. Ethanol blended fuel should not be allowed to sit for more than 90 days as it absorbs water.

A long term recommendation for the fire department is to identify all other locations within the city that has ethanol stored in any sizeable quantities. This could be accomplished

through ongoing inspections and by also contacting the petroleum delivery dealers and cooperatively identifying ethanol facilities located within the city limits. Any identification should lead to preplans of those facilities. Transportation routes supplied by these dealers of vehicles transporting ethanol above 20% should be preplanned. The preplans should include:

- Identify the methods of shipping
- Identify the water supply challenges
- Identify the quantity of foam needed to handle spill
- Identify protection considerations for surrounding communities.
- Future training is recommended with the fire department and facility personnel.

For anyone conducting this research, I would recommend contacting the International Fire Chiefs Association to provide a mailing list for specific organization for those states that you want to survey. Even though survey monkey is a much easier tool to use than the hand written format and mailed survey, this researcher believes that responses may have been returned for Illinois and Minnesota had they been sent to specific members of specific organization.

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Appendix A

Recommended SOP

Boca Raton Fire Rescue Services Standard Operating Procedures		S.O.P. # Effective: April 30, 2010 Revised:
_____ Fire Chief Signature	_____ Date	Page: 1 of 2
Division: Operations		
Subject: Flammable Liquids Response		
Policy: The objectives of this SOP are to reduce the loss of life, environmental impact and property damage by establishing a standard method of operation for companies operating at flammable liquid emergency incidents.		
Scope: All Personnel		
Procedure: Boca Raton Fire Rescue acknowledges that all incidents involving spills and/or fires of Class B fuels must be carefully managed.		
Modes of Operation There are three operating modes typically used at an incident involving a flammable liquid: Offensive attack mode, defensive attack mode, and non-intervention mode. Offensive attack mode is a commitment of resources to aggressive leak, spill, and fire control objectives. This operating mode is used where additional risk is justified because rescue operations can be quickly achieved, the spill or leak can be quickly contained, or the fire can be quickly extinguished.		
The defensive attack mode uses available resources to achieve less aggressive objectives, such as limiting the overall size or spread of the problem. This operating mode is used where the benefit of offensive attack is not worth the risk involved but where other actions can be taken to mitigate the hazard or protect exposures.		
Non-intervention mode means taking no immediate action other than isolating the area until the risk of intervention is reduced to an acceptable level so that operations may transition to offensive or defensive strategies. This operating mode may be used while assembling resources to commence a migration strategy.		
On-Scene Operations The first engine company officer shall perform the initial size-up (thinking RECEO), establish command and identify any obvious life hazards. During the size-up, note any visual indicators of hazards, such as smoke, vapor clouds, active leaks or odors. The initial Incident Commander will determine the operational mode and will initiate hazard protection for life safety and rescue measures if deemed necessary. Eliminate ignition sources. A protective foam blanket may be one method to accomplish this task.		

Boca Raton Fire Rescue Services Standard Operating Procedures		S.O.P. # Effective: April 30, 2010 Revised:
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On-Scene Operations ^{cntd.}		
<p>The first arriving engine should make contact with a facility representative, determine the current situation, and ask about any actions taken prior to arrival of fire department personnel. The first arriving engine should perform reconnaissance (recon) of the suspected hazard area for Leak/Spill/Fire. Recon teams should be equipped with appropriate PPE, detection equipment, binoculars, and TIC. The recon team must comply with the two-in, two-out rule.</p>		
<p>The reconnaissance report should answer the following questions:</p> <ul style="list-style-type: none"> • Is there any life hazard? • What is the product type? Is it flammable or combustible? Is it a hydrocarbon or polar solvent? • Is the product still leaking? • What is the flow rate of the leak? • Can the leak be controlled? • How much has been spilled? • What is the approximate surface area of the spill or fire? • What is the total potential spill? • Is the spill or fire contained? • Where is the product going? • For a spill, are any potential ignitions sources present? • For fires and spills, what are the primary and secondary exposures? • Is the area secure from unauthorized entry? 		
<p>Small spill responses involve containers or packages that contain 25 gallons or less of product. Small spills may be managed by an engine company and the hazardous material response vehicle. Large spill responses include any incident involving more than 25 gallons. This response requires a Regional Hazardous Materials Response as well as the Battalion Chief.</p>		
<p>Water application during a flammable liquids fire is not an effective extinguishing method. Ethanol fires may be extinguished with water using an application rate of approximately 9 gals of water to 1 gal of ethanol. Care must be used to contain and then collect the entire mixture if water is used on such a fire.</p>		
<p>For vapor suppression or fire extinguishment, foam will be applied at the manufacturer's concentration level for polar solvent on all flammable liquids fires. During a regional response it may be necessary to verify that only type AR-AFFF foam is being applied to flammable liquids spill or fire.</p>		
<p>Efforts should be made to keep the flammable product out of storm and sanitary sewers, waterways, and ground water sources. Actions initiated will be to reduce the rapid spread of the product from the initial spill site.</p>		

Appendix B

Survey Questions

1. Do you have an E-85 fuel station or distribution center or production facility in your jurisdiction?
Yes No

2. Do you provide training to fire fighters in handling ethanol emergencies?
Yes No

3. Does the training provided include any or all of the following (Select all that apply).

Classroom
Field/foam extinguishing exercise
Rail car
Distribution or Productions Facility
E-85 Fuel Stations
N/A

4. How often do you provide on-going training following the initial training?
None
6 months
12 months
24 months
Other (please specify)

5. Who provided the initial training?
Fire department developed and delivered
IAFC developed / In-house delivered
IAFC developed / Industry provided instructor
Industry developed / Industry provided instructor

6. Do you have written SOP's to deal with ethanol emergencies? If yes, please provide a copy of the SOP by email to: dwoodside@myboca.us
Yes No

7. Do you have a pre-plan of ethanol facilities in your jurisdiction?
Yes No

8. Do you have mutual agreements for ethanol response with other surrounding jurisdictions?
Yes No

9. What safety procedures do you have in place or established to respond to ethanol incidents?

10. What techniques do you teach and/or employ for fires involving ethanol incidents?
11. What specialized equipment do you use to deal with ethanol emergencies?
12. List the top five challenges you are facing (or have faced) trying to plan for and respond to ethanol emergencies?
13. List City
14. List Zip Code
15. Rank
 - Executive officer**
 - Chief officer**
 - Operations officer**
 - Fire fighter**
 - Other (please specify)**
16. Please add any additional information that you would like to share about ethanol emergencies

Appendix C

BRFRS TAPIRS TS212

BOCA RATON FIRE-RESCUE SERVICES

TAPIRS

ISSUED BY: Thomas R. Wood, CFO, Fire Chief
ORIGINATED BY: David Woodside, Assistant Fire Chief

ISSUED DATE: 03/01/2007 EFFECTIVE DATE: 04/30/2010 NUMBER: TS 212

SUBJECT: Firefighting Foam

AMENDS RESCINDS REFERENCE:
212.1

The only foam to be carried in the apparatus foam tanks is "Ansulite 3 X 6" (brand name). This is an AFFF, alcohol resistant concentrate (ARC), which is to be used on class B flammable liquid fires/spills (hydrocarbons @ 3%, polar solvents @ 6%).

Note: Due to various additives to gasoline, a 6% solution shall be the only concentration used on flammable liquid fires.

The foam labeled "Silvex" should **not** be added to the apparatus foam tanks that contain the "Ansulite 3x6" ARC foam. The "Silvex" brand is a class A, alcohol-based foam concentrate that will adversely react with the ARC foam causing jell-like globules to form which have a consistency similar to pizza dough. These globules will eventually obstruct the foam outlets and eductors.

Note: The "Silvex" foam may be poured directly into the booster tank (at the right proportion) if a wetting agent is needed.

